BTeV Schedule Overview

Joel Butler

Overview

- The Response to the recommendations of the Lehman review and Office of High Energy Physics request for new schedules
- General Description of Changes to BTeV schedule to satisfy recommendations of Lehman Review
- Methodology used in scheduling
- Installation Issues with the New Schedule
- Schedule, cost and resource rollup for the whole project

The schedules for the detector subprojects and a discussion of the installation periods are the subject of another talk.

From the Lehman Review

- The summary recommendation from the Lehman CD-1 review
  - "Develop a schedule and funding profile for BTeV, such that the desired scientific capabilities are obtained while ensuring that the scientific output is competitive and timely. Provide revised plans to DOE as soon as possible, to support the CD-1 decision process.''

From the Office of High Energy Physics

- Two schedules were requested by Robin Staffin
  - "The Laboratory and BTeV collaboration would present to the DOE a new schedule that is generally based on the technical scope and funding profile that was presented to the Lehman review. This schedule should include sufficient float to insure completion of the project. Estimates from the review team indicate that this will require an additional 6 to 12 months in the duration of the project. The Laboratory and BTeV collaboration may include in this scenario a stage at which physics operation would start with an incomplete detector before completion of the project."
  - "The Laboratory and the BTeV collaboration would present a new plan that involves more financial and possibly more manpower resources in the next few years (FY 05 to FY07) in order to preserve the FY09 completion date for the full experiment."

The first schedule is due "before June 15" and The second "by July 1."

Changes to CD-1 Schedule for FIRST New Schedule

- Staged Installation of the Detector: The detector will be installed in two stages
  - The first stage will be installed in a shutdown from August1, 2009 to November 30, 2009. That will be followed by a 7 month run.
  - The second stage will be installed in a shutdown beginning in early July of 2010 and lasting 3 months until Sept. 30, 2010.
- Impact of Additional Resources
- Reallocation of Resources within the Project
- Adoption of Explicit Recommendations and Suggestions from the Review
- Effect of More Work on Specific Issues Raised in the Review
- More Total Time for Installation
- Scrubbing of the whole Schedule

Staging - I

- Stage 1 (August 1 – Nov 30, 2009): An Excellent Detector -75% of full detector's capability for B's decaying into all-charged final states and 50-60% of the full detector's capability for B's decaying into final states containing photons
- There is a run from Nov 30, 2009 to end of June 2010.The first month will be used for commissioning the IR, followed by detector commissioning and then data-taking
- Stage 2 (July 1 –Sept 30,2010): All remaining elements of the Liquid RICH, EMCAL, forward tracker and Muon Detector installed in C0. Trigger and DAQ components can be installed in the Counting Room as they arrive in 2009 and early 2010. When running resumes, we will have the full BTeV detector.

Staging - II

- The Staged Installation achieves four key goals
  - Provides much more "float" since 2009 budget authority can produce results that have significant float with respect to the second installation stage.
  - Provides significantly more time for installation – 30 weeks vs 17 in the schedule presented at the CD-1 Review
  - Provides additional safety margin for Lead Tungstate Crystals in case their arrival is delayed by CMS' problems (discussed in talk by M. Lindgren)
  - Provides a fully competitive, indeed superior , detector with respect to LHCb on schedule in 2009 (discussed in talk by Sheldon Stone).

Beginning in August 2009 when Run 2 ends, the Tevatron schedule will be set based on BTeV's needs.

Impact of Additional Resources - I

- New INTERNAL resources added to the project have allowed us to adjust the schedule to make it more likely to be achieved
  - **Fermilab has provided funds for the next phase of conceptual design of the C0 Outfitting. Work will start June 1. This will ensure that the design will be completed well before the time when it is necessary to go out to vendors with a bid package. This also frees up some badly needed FY05 funds that are applied to accelerate the Pixel Detector**
  - **Fermilab has added two engineers to the IR design team. This has allowed them to begin a design study for the Spool assembly this year**

Impact of Additional Resources - II

- New EXTERNAL resources added to the project have allowed us to adjust the schedule to make it more likely to be achieved
  - **The INFN has informed DOE and Fermilab that its Scientific Committee (CSN1) has approved the scientific case for BTeV and the involvement of Milano, Frascati and Pavia in the project, contingent of course on its final approval in the US. They plan to fund a major part of the Forward Silicon Microstrip tracker, participation in the Forward Straw tracker commensurate with the involvement of the Italian groups, and the Fiber Bragg Grating alignment system. The initial indication is for $6M M&S and associated personnel costs in Italy. This permits redistribution of funds to solve many of the scheduling problems**
  - **Syracuse University has agreed to $7.5M of forward obligation authority for the BTeV Project**

Reallocation of Resources within the Project

- There have been several changes to the funding allocations within the project. Two examples are:
  - $300K more for Pixels in ’05 and $1.4M in ’06 has speeded up their schedule
  - Moving money from ’09 to ’08 for the Trigger and DAQ has given their schedule a lot more float

Adoption of Explicit Recommendations from Review

- Examples include
  - The committee recommended doing several of the pixel procurements as continuous contracts with options to give the pixel detector more float. It also recommended extending the time from the start of bump bonding to when all detectors were tested from 13 to 18 months.
  - The committee suggested leaving the EMCAL support stand outside C0, giving more access to install crystals right up to the main installation period in 2009

Effect of More Work on Issues Raised in the Review

- This work will be discussed in the talk by Mike Lindgren

More Total Time for Installation

- The committee generally recommended more time for installation
  - The new staged schedule has 30 weeks for installation vs about 17 in the old schedule. Details of the installation activity will be discussed in the next talk.
  - All our installation plans are based on single shift 5-day/week operation, so going to double shifts is a work-around
  - Our task is not as great as KTeV's installation task, which took place in 6 months. When we start in 2009, we will have the infrastructure components installed. KTeV had to install those at the start of their six month period.

Scrubbing of the Schedule

- We have worked hard to undo some linkages that we found that did not seem to be necessary
  - Some tasks were not allowed to proceed until preceding tasks were 100% completed even though they did not need the full output of their predecessors.
    - **In the Straw task, station assembly was not started until 100% of the electronics arrived but, since assembly is sequential, it could start much earlier. Now it is scheduled to start when the first 25% of the electronics is available**

Description of Improved Scheduling Methodology

- To discuss the BTeV schedule, we have to separate the construction of detector and IR components from the installation.
  - The construction spans a four to five year period and involves interactions with many external vendors.
  - The bulk of the installation takes place over a period of ~7 months, distributed across two accelerator shutdown periods, and largely uses resources under the control of the BTeV project and Fermilab.
  - The assessment of schedules and judgment of adequacy of schedule float depend on this separation

"Ready By" and "Need By" Dates

- "Ready by" dates apply to the construction phase. Each subtask team is asked to make a schedule (taking into account any linkages to other subtasks) for each component that they are providing based on the best knowledge they have or can acquire of activity durations. This leads to a probable date when each component is complete and ready to install – the "Ready By" date.
  - **Ready By dates can be given for all components (in which case it is the latest Ready By date of all the subcomponents), of a subgroup of components that are to be installed together, or, where appropriate, of a single component.**
- "Need by" dates apply to the installation phase. The leader of the Integration and Installation Subproject, working with the subproject teams, defines an installation schedule relative to the scheduled Tevatron shutdowns. This determines the most probable date on which a detector or a subcomponent is needed for installation – the "Need By" date.

"Installation Complete" Date and "Total Float"

- The "Installation Complete" date also applies to the installation phase. For each installation activity it is determined by assigning the most probable duration to each part of the installation.
- Calculation of "Total Float": With this approach the "total float" for any given construction activity is the number of working days between its "Need By" date and its "Ready By" date. For an installation activity, it is time between the end of the "Installation Complete" date and the end of the relevant installation period.

Adequacy of Total Float

- Assessment of the Adequacy of Total Float:
  - **whatever the total float turns out to be, it is important to establish that it is adequate to ensure that the task has a very high probability of being completed.**
  - **We achieve this by examining the critical path and "near critical path" activities, assessing what delays are possible and studying their impact, individually and together, on the schedule.**
  - **To facilitate this, we have established a set of "Zero Day Contingency" activities positioned at key points of scheduling uncertainty.**
  - **We then add our estimate of possible schedule contingency usage for each activity, which generates an alternative schedule with a distributed float, rather than one concentrated at the end. These delays could change the project critical path. If after distributing this "delay", the project still concludes before the "Needed By" date, then we conclude that the subtask is highly likely to be completed on schedule. This assumes that the delays all occur.**

Summary of Revised Schedule - I

With these changes the schedule has much more float

- Key "Need by" and "Ready by" dates (20 working days/month):

Subproject	"Ready by"	"Need by"	Float (working days)
Magnet, Toroid	Jul. '06	Feb. '07	145
Pixel Detector	Sep. '08	Aug. '09	229
RICH Tank	Oct. '07	Sep. '08	202
RICH MaPMT	Jun. '08	Nov. '09	235
RICH PMT Array	Jul. '09	Jul. '10	239
RICH Liquid circulation	Jul. '09	Jul. '10	197
50% Crystals Loaded	Apr '08	Sep. '09	229
100% Crystals Delivered	Sep. '09	Aug. '10	191
Muon Station 2/3	Sep. '07	Aug. '09	474
Muon Station 1	Sep. '08	Aug. '10	475
Muon Gas System	Mar. '07	Sep. '08	382

Summary of Revised Schedule - II

- Key "Need by" and "Ready by" dates (20 working days/month):

Subproject	"Ready by"	"Need by"	Float (working days)
Straw station 1,2,5,6,7	Oct. '08*	Aug. '09	218
Straw station 3,4	May '08	Jul. '10	540
Microstrip Tracker	Dec. '08	Aug. '09	186
50% of Trigger	Feb. '09	Oct '09	156
100% of Trigger	Sep. '09	Aug. '10	223
50% of DAQ	Sep. '08	Aug. '09	220
100% of DAQ	Mar. '09	May '09	310
IR Quads	Dec. '08	Sep. '09	200
IR Spools	Jan. '09	Sep. '09	175
C0 Assembly Area	Dec. '05	Jul. '06	157

* Station 7 date, others complete in April, May '08

Cost by Subproject by Fiscal Year

Activity ID	Base Cost ($)	Material Contin-gency (%)	Labor Contin-gency (%)	Total FY05	Total FY06	Total FY07	Total FY08	Total FY09	Total FY10	Total FY05-10
1.1	1,866,664	26	24	178,045	1,438,283	465,137	256,776	6,868	0	2,345,109
1.2	15,363,375	43	39	2,283,124	7,816,045	6,132,910	4,910,051	507,844	0	21,649,974
1.3	12,095,831	38	28	672,598	4,551,404	6,520,698	3,888,084	853,837	0	16,486,621
1.4	12,553,126	35	28	539,890	2,490,006	4,797,627	4,714,283	4,223,956	0	16,765,762
1.5	4,211,242	45	27	520,654	2,412,260	1,851,111	1,097,154	0	0	5,881,179
1.6	9,759,474	26	32	817,027	4,041,326	4,213,614	3,255,255	229,146	0	12,556,368
1.7	7,473,389	36	32	953,351	2,290,898	2,543,365	4,001,984	220,456	0	10,010,054
1.8	12,144,431	33	53	783,388	2,570,916	2,229,985	6,618,435	4,972,216	0	17,174,940
1.9	12,184,272	41	29	436,497	2,662,466	3,624,290	5,955,402	3,598,323	109,104	16,386,082
1.10	7,592,576	22	78	191,057	843,782	1,619,752	2,801,158	3,250,384	3,684,585	12,390,718
2.0	26,026,672	36	40	7,455,048	10,966,126	7,250,517	6,096,068	3,186,572	956,473	35,910,804
3.0	5,771,006	21	20	1,763,228	2,592,526	2,605,706	0	0	0	6,961,460
4.0	5,713,380	22	23	1,089,928	1,425,459	1,433,768	1,301,795	1,302,084	493,472	7,046,506
Total	**132,755,438**	**35**	**39**	**17,683,835**	**46,101,497**	**45,288,480**	**44,896,445**	**22,351,686**	**5,243,634**	**181,565,577**

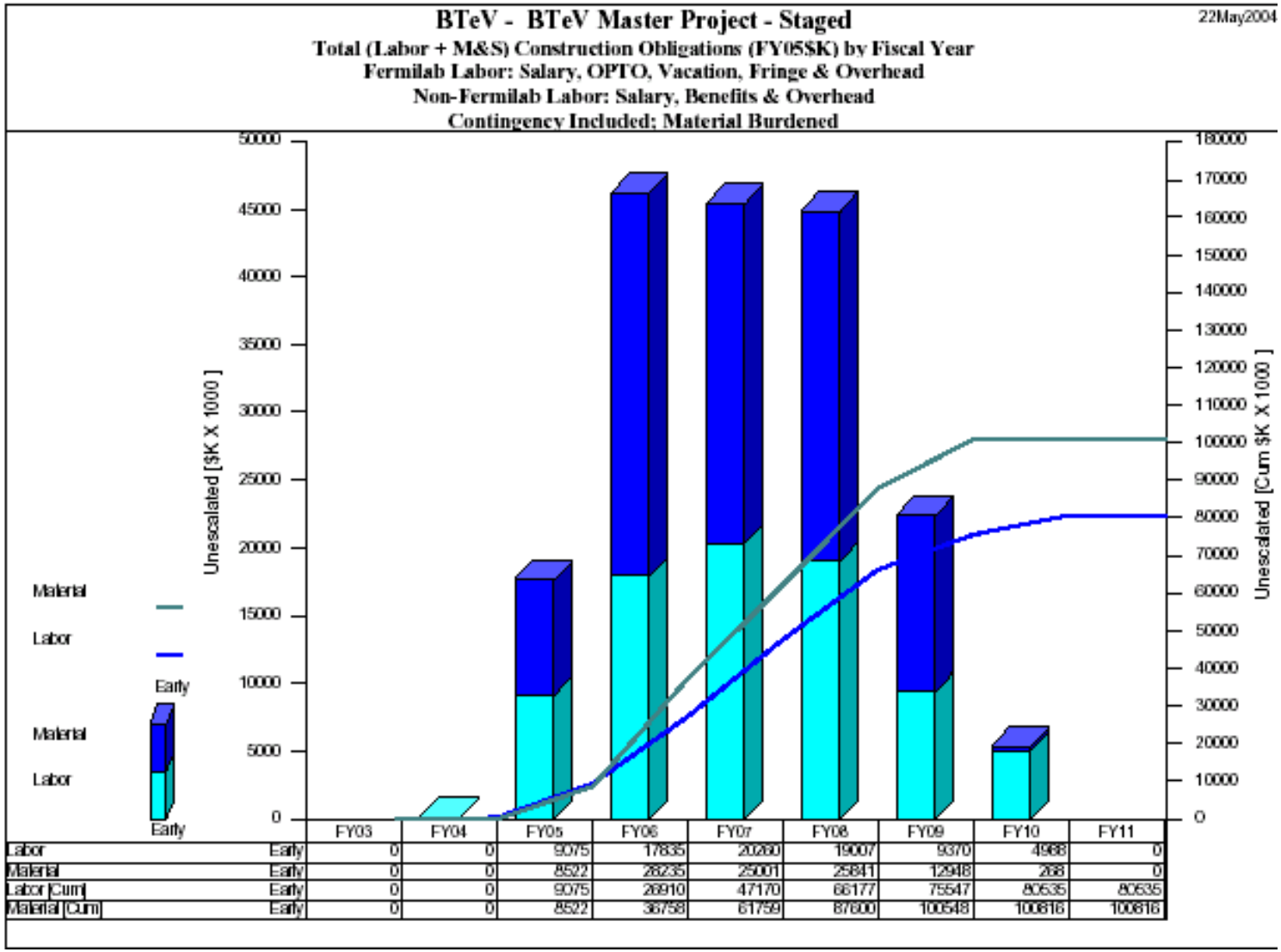
FY05 $ (construction only, no IR spares)

Total Cost and Comparison to CD-1 Review

Total Cost in FY05$			
In $millions	**Apr Rvw**	**May Rvw**	**Difference**
1	$ 127.71	$ 131.68	$ 3.97
1.1	$ 2.22	$ 2.35	$ 0.13
1.2	$ 21.65	$ 21.65	$ -
1.3	$ 16.44	$ 16.49	$ 0.05
1.4	$ 16.32	$ 16.77	$ 0.45
1.5	$ 5.14	$ 5.89	$ 0.75
1.6	$ 12.27	$ 12.57	$ 0.30
1.7	$ 10.00	$ 10.01	$ 0.01
1.8	$ 17.05	$ 17.17	$ 0.12
1.9	$ 16.34	$ 16.39	$ 0.05
1.10	$ 10.28	$ 12.39	$ 2.11
2	$ 36.06	$ 35.91	$ (0.15)
3	$ 7.21	$ 6.96	$ (0.25)
4	$ 6.48	$ 7.06	$ 0.58
	$ 177.46	$ 181.61	$ 4.15

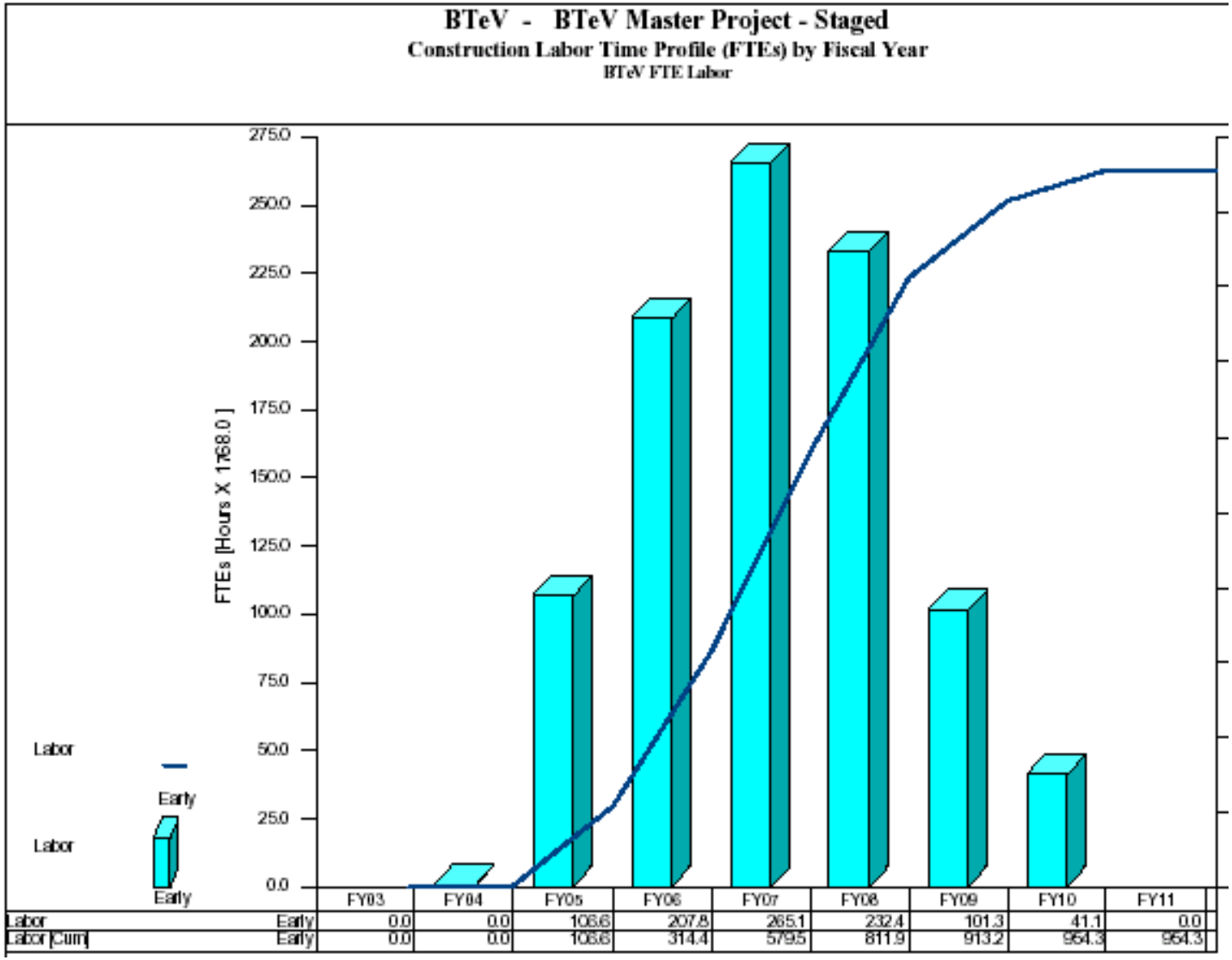
Costs have risen by $4.15M. Biggest effect is due to added contingency for 1.10 ($2M) recommended by reviewers and cost of longer shutdown period. Project Office costs increased to cover the longer project period.

Overall Cost Profile

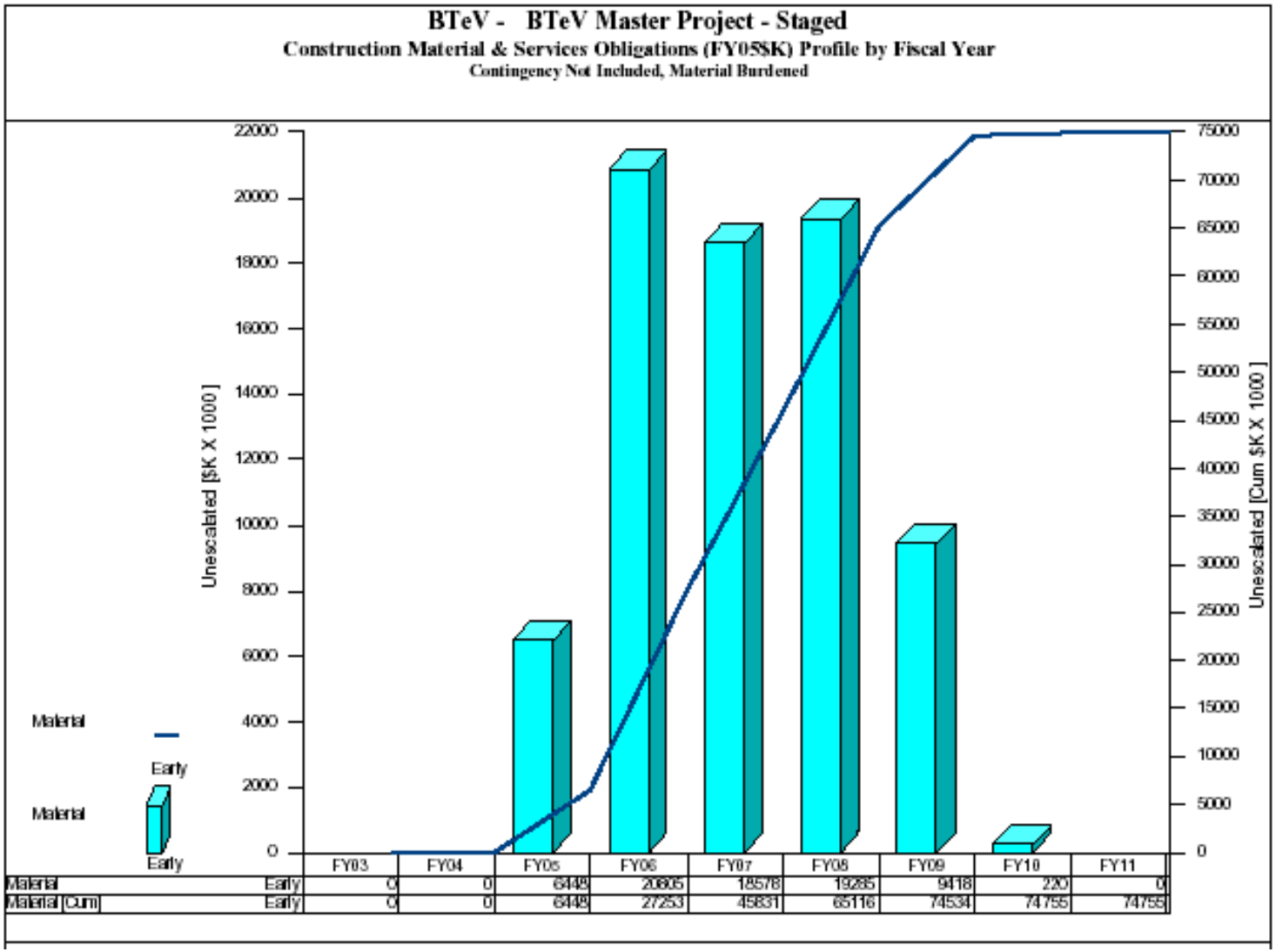


		FY03	FY04	FY05	FY06	FY07	FY08	FY09	FY10	FY11
Labor	Early	0	0	9075	17835	20260	19007	9370	4968	0
Material	Early	0	0	8522	28235	25001	25841	12948	268	0
Labor [Cum]	Early	0	0	9075	26910	47170	66177	75547	80635	80635
Material [Cum]	Early	0	0	8522	36758	61759	87600	100548	100816	100816

Labor Profile



M&S Profile


BTeV - BTeV Master Project - Staged
Construction Material & Services Obligations (FY05$K) Profile by Fiscal Year
Contingency Not Included, Material Burdened
Unescalated [$K X 1000]
Unescalated [Cum $K X 1000]
Material
Early
Material
Early
FY03 FY04 FY05 FY06 FY07 FY08 FY09 FY10 FY11
Material Early 0 0 6448 20805 18578 19285 9418 220 0
Material Cum Early 0 0 6448 27253 45831 65116 74534 74755 74755

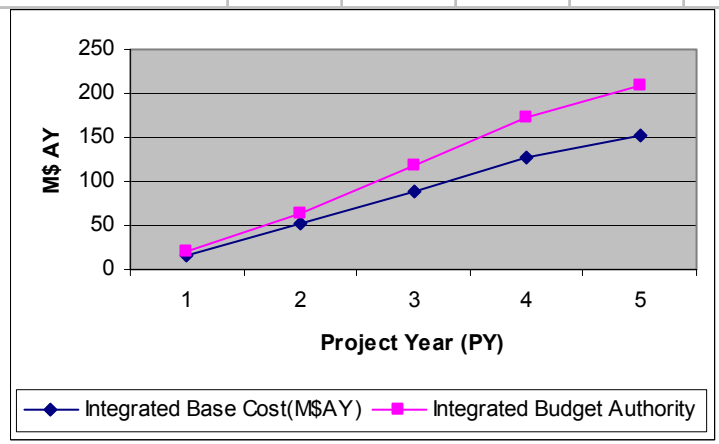
Project Critical Path for Construction

- The Project Critical Path for the Construction phase is determined from the exercise, using the most probable durations, as the projects with the shortest total floats.
- We then consider the
  - **likelihood of delays at key places in the schedule cutting into the available float.**
  - **the impact of a delay to the Installation schedule and to the physics readiness**
- Through this process, we have identified the critical and near-critical path items as
  - **The IR (spools, quads)**
  - **The Pixel detector**
  - **The 50% (Stage 1) Trigger**
  - **Stage 2 EMCAL (arrival, installation)**
- There are a few other projects with short (even shorter) floats for which there is considerably less uncertainty and which are no tdirectly on the critical path

The Critical Path will be shown in detail in the next talk.

Funding Requirement vs Available Budget

Cost Profile - M$ AY	FY05	FY06	FY07	FY08	FY09/10	
Equipment Base Estimate	6.75	31.3	37.9	35.2	19.3	130.45
Contingency	2.2	10.5	13.5	12.9	8.1	47.2
Total Equipment	8.95	44.9	48.2	49.3	31.5	182.85
IR Spares	1.5	0	1.7	1.8	1.7	6.7
IR Spares Contingency	0.6	0	0.5	0.7	0.7	2.5
R&D	6.75	2.2	0	0	0	8.95
R&D Contingency	2.1	0.6	0	0	0	2.7
Total BTeV Costs	19.9	47.7	50.4	51.8	33.9	203.70
Availability of Funds - M$ AY						
R&D DOE	4.24	2.2	0	0	0	6.44
OP DOE	2.1	0	2.2	2.3	2.4	9
MIE DOE	6.75	39	49	49.4	42.5	186.65
Total DOE	13.09	41.2	51.2	51.7	44.9	202.09
Univ Forward Funding	7.5	0	0	0	-7.5	0
INFN	0.75	1.73	1.88	3	0.15	7.51
NSF	0	0	0	0	0	0
Total Anticiapted BA	21.34	42.93	53.08	54.7	37.55	209.6
Integrated Total BTeV Base Cos	15	51.6	88	126.2	151.3	
Integrated Total BTeV BA	21.34	64.27	117.35	172.05	209.6	



Tiered Milestones

- Tier 0 and Critical Decisions: Deputy Secretary (1, PEP)
- Tier 1: Office of Science/ Office of High Energy Physics (8, PEP, BTeV Doc # 2908)
- Tier 2: DOE Project Director (27, PMP, BTeV Doc # 2950)
- Tier 3: Fermilab Director/BTeV Project Manager (92, PMP, BTeV Doc# 2895)
- Tier 4: BTeV Level 2 Manager (BTeV Schedule)
- Tier 5: BTeV Level 3 Manager (BTeV Schedule)

These are "proposals" drawn from the existing schedule and are chosen to enable the relevant holder of the milestone to monitor the BTeV Project at the appropriate level of responsibility. They are distributed uniformly across the project timeline. The milestones must be agreed to by the "holders". We have already installed the proposed set in Open Plan. "Internal dates" are based on "most probable" durations. "Formal dates" are based on assessment of possible delays and are the ones that are monitored.

Tier 1 Milestones

No.	WBS	Milestone	Internal Date	Formal Date
L1-1	2.0	Purchase Order awarded for superconducting wire		
L1-2	3.0	Beneficial occupancy of lower level and upper staging area of C0		
L1-3	1.1	Vertex Magnet installed in C0 and powered		
L1-4	1.2	PO awarded for production pixel hybridization		
L1-5	1.4	20% of PWO Crystals accepted		
L1-6	1.2	Pixel System assembled and tested at SiDet, ready to ship to C0		
L1-7	2.0	IR Components complete, installed and under power		
L1-8	1.0,1.10	Detector complete and ready for commissioning with beam		

Tier 2 Milestones

WBS	Milestone	Internal Date	Formal Date
1.1	Vertex Magnet installed in C0 and powered		
1.2	Purchase order placed for pixel readout chip		
1.2	Purchase order placed for pixel detector hybridization		
1.2	PO awarded for production pixel hybridization		
1.2	Pixel System assembled and tested at SiDet, ready to install in C0		
1.3	Rich Tank Installed in C0		
1.3	MAPMT PO awarded		
1.4	QIE PO awarded		
1.4	20% of PWO Crystals accepted		
1.4	80% of PWO Crystals accepted		
1.4	EMCAL Support structure (partially loaded) installed		
1.5	Beginning of octant production		
1.6	ASDQ PO awarded		
1.6	Station 1 ready for installation in C0		
1.7	Readout IC approved for production		
1.7	First FSIL station ready to be installed in C0		
1.8	Trigger pilot system tested		
1.8	First production release of Level 2/3 Trigger software		
1.9	Data Combiner Board pre-production units tested and approved		
1.9	Multinode release of Data Acquisition RCS package		
2.0	Purchase Order awarded for superconducting wire		
2.0	IR Components complete and ready to install		
3.0	C0 Outfiting Start Construction		
3.0	Beneficial occupancy of lower level and upper staging area of C0		
3.0	C0 Outfitting construction complete		
2.0	IR Components complete, installed and under power		
1.0, 1.10	Detector complete and ready for commissioning with beam		

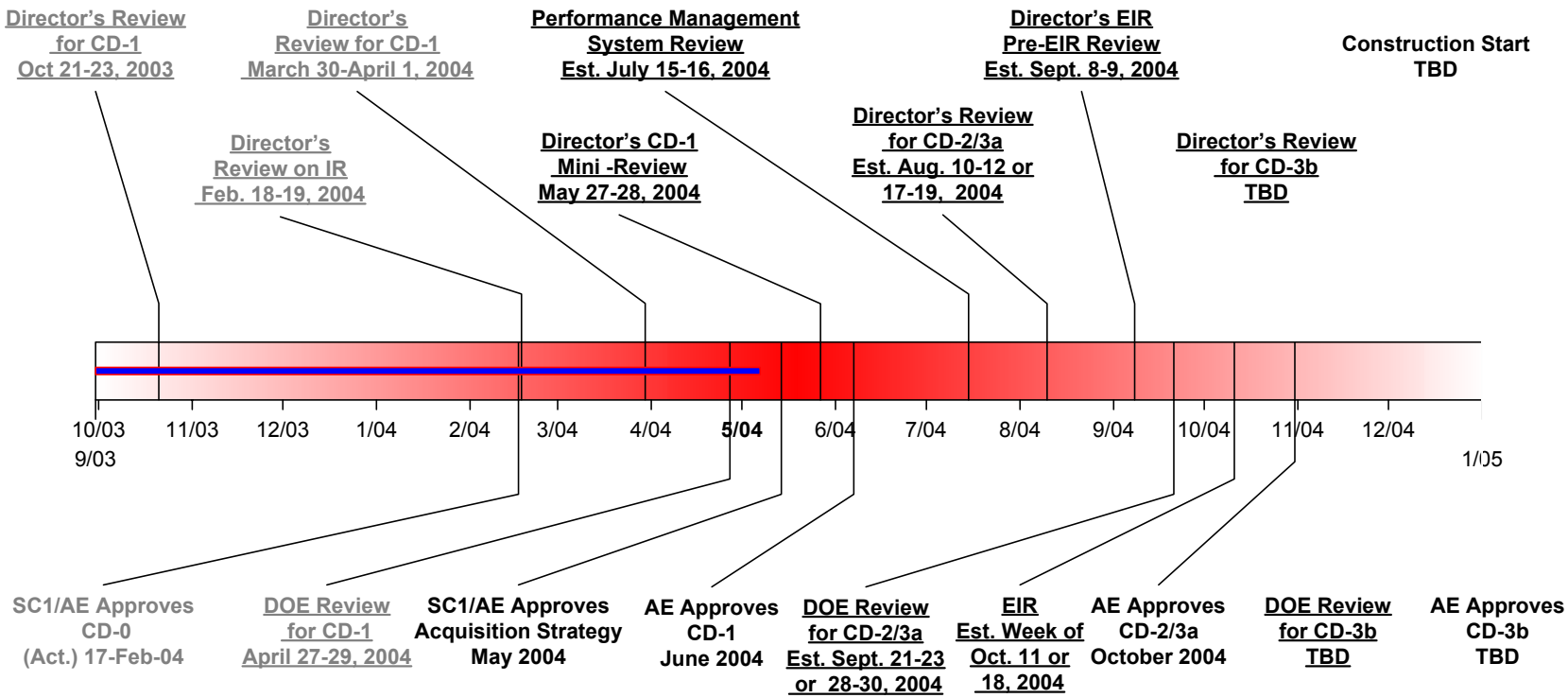
DOE CD Milestones

- Would like CD-4 date to be 3Q2011 (moved from 1Q2011) due to staging.
- This BTeV schedule is based on schedule for Critical Decisions shown on next slide
- Some early procurements and some design effort need to occur towards the beginning of the project (these will be discussed in the next talk) or we will have to modify this schedule.

CD Timeline from Fermilab

BTeV Project Schedule for Critical Decisions & Reviews Timeline

Updated 06-May-04



12-May-04 BTeV PMG Working Meeting

Conclusions

- Cost
  - The new schedule results in a 2% increase
  - We will probably add between $0.5-1.0M more labor in the Project Office
  - This is more than offset by the funding from the INFN
- Schedule
  - The new schedule has large floats for all **construction** subtasks in the project and should be achievable
  - The extra installation times gives us about a 20-30% contingency on **installation** activities without assuming double shifts
- Technical Scope and Design is same as that endorsed by CD-1 review
- Physics competitiveness is excellent, even assuming that LHC startup goes very well